Charles Darwin University

Final Examination

Family Name						
Given Name/s						
Student Number						
Teaching Period	Semester 2, 2018					

SBI209^ – Design and Analysis of Biological Studies - Special Exam	DURATION	
	Reading Time:	10 minutes
	Writing Time:	180 minutes

INSTRUCTIONS TO CANDIDATES

Answers should be written in the booklet provided.

Please ensure that your Name and Student Number are written clearly in the space provided at the top of the booklet.

Note that questions ARE of equal value.

Read ALL questions carefully.

Do not commence writing until instructed to do so.

Writing on scrap paper during Reading Time is permitted.

EXAM CONDITIONS

You may begin writing from the commencement of the examination session. The reading time indicated above is provided as a guide only.

This is a RESTRICTED OPEN BOOK examination

Any calculator is permitted

No handwritten notes are permitted

Hard copy, unannotated English translation dictionary only

ADDITIONAL AUTHORISED MATERIALS	EXAMINATION MATERIALS TO BE SUPPLIED
	1 x 8 Page Book 1 x 20 Page Book Formula Sheet/s Statistical Table/s

THIS EXAMINATION IS PRINTED DOUBLE-SIDED.

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Twelve (12) short-answer questions

Total number of marks for this section: 180

This section should be answered in the booklet(s) provided.
Please ensure that your name and student number have been written on the booklet(s).

Marks for each question are indicated.
Suggested time allocation for this section: 180 minutes.
Numbers in [] give the source of the data.

Question 1

An athlete is practising archery. During a session, results show he hits the bulls eye 9 times out of every 10 shots (p = 0.9). He has a quiver with 5 (five) arrows. Work out the **probabilities** of the following outcomes:

(i) none (0 out 5) hit the bulls eye

(ii) four (4 out of 5) hit the bulls eye

(iii) five (5 out of 5) hit the bulls eye

(15 minutes = 15 marks)

Question 2

Information is collected on the numbers of male and females with educational qualifications at different levels [1]. Test the following null hypothesis using the data in **Table 1**.

H_0: There is no difference between males and females in proportions with different qualifications.

Table 1: Numbers are counts of numbers of people with different qualifications.

Education→	**High school**	**Bachelors**	**Masters**	**PhD**
Male→	60	54	46	41
Female→	40	44	53	57

(15 minutes = 15 marks)

Question 3

A biologist tests his new "cane toad repellent" device by installing one device next to a pond in a wildlife park, along with a video surveillance camera. After two nights, he watches the tape and sees no cane toads. His device works! Is his conclusion valid (i.e. correct)? If not, why not?

(15 minutes = 15 marks)

Question 4

Discuss **simple random sampling**, **stratified sampling** and **cluster sampling**, referring to the three (3) attributes (features) listed below. Give an example of each of these three types of sampling scheme (simple random sampling, stratified sampling and cluster sampling**)**, illustrating how each of the attributes applies.

(i) Precision

(ii) Accuracy

(iii) Efficiency (ease of use)

(15 minutes = 15 marks)

Question 5

A study is done in a city to test the null hypothesis "H_0: Laser surgery to correct vision (eye) problems has no adverse (bad) side-effects". Describe the potential consequences in the following two situations:

(i) A Type I error is made.

(ii) A Type II error is made.

(15 minutes = 15 marks)

Question 6

A study was done to determine the pressure applied to the head during an impact was the same for cars of different sizes [2]. The data is pressure experienced by instruments in crash test dummies in the cars. There were three (3) replicate tests for each size of car. Complete the analysis in **Table 3**, and do any other procedures required, to test the following null hypothesis:

H_0: Mean pressure is the same for all sizes of car.

Table 2: Mean pressure experienced in three sizes of car

Car size→	**Small**	**Medium**	**Large**
Mean pressure→	666.7	473.7	447.3

Table 3: Partially completed analysis of data

Source	**SS**	**df**
Among	86050	2
Within	10254	6
Total	96304	8

(15 minutes = 15 marks)

Question 7

The Dark-stemmed Antler Orchid is a flower which may grow as a parasite on mangroves. A botanist surveys one hundred (100) trees in a mangrove forest gets the following results: 48 trees had no (0) orchids, 32 trees had one (1) orchid, 15 trees had two (2) orchids, 4 trees had three (3) orchids and one tree had four (4) orchids. Test the following null hypothesis:

H_0: Orchids are distributed at random among mangrove trees in the forest.

(15 minutes = 15 marks)

Question 8

The pH of the yolk of a freshly laid egg is about 6.0 but as time passes the pH increases [3]. As part of routine monitoring, the pH of the yolk of eggs from two farms is tested by randomly selecting five (5) eggs from the day's harvest. For each farm, using the data in **Table 4**, test the following null hypothesis:

H_0: Mean pH of the yolk of the eggs equals 6.0.

Table 4: pH in the yolk of five (5) eggs from each farm.

Farm 1 samples→	**1**	**2**	**3**	**4**	**5**
pH→	4.5	8.1	6.7	5.0	6.6
Farm 2 samples→	**1**	**2**	**3**	**4**	**5**
pH→	9.1	9.8	11.6	9.4	8.7

(15 minutes = 15 marks)

Question 9

This example looks at the strength of the link between the price of a bottle of water and distance from the Contemporary Art Museum in El Raval, Barcelona [4]. It is probable that the price of a bottle of water *decreases* as distance from the Contemporary Art Museum *increases*, due to higher property rents closer to the museum. Using the data in **Table 5**, test the null hypothesis below:

H_0: Price is not correlated with distance.

Table 5: Distance of store, and price of drink, for seven (7) stores

Store→	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Distance→	50	175	375	425	580	790	980
Price→	1.8	1.2	1	1	1.2	0.6	0.85

(15 minutes = 15 marks)

Question 10

A wild pack of Chihuahuas, terrorizing the countryside, has a mean height of 19.2 cm, with a standard deviation of 3.8 [5]. Calculate the following proportions.

(i) the proportion of Chihuahuas with a height **greater** than 23 cm

(ii) the proportion of Chihuahuas with a height **less** than 15.4 cm

(iii) the proportion of Chihuahuas with a height **between** 15.4 and 23 cm

(15 minutes = 15 marks)

Question 11

A company researcher wants to test a new formula for a sports drink that has been designed to improve running performance [6]. Instead of the regular "carbohydrate-only" drink, the new sports drink contains a "carbohydrate-protein" formula. To carry out the experiment, the researcher recruited six (6) middle distance runners. All of these participants performed two trials in which they had to run as far as possible (km) for two (2) hours on a treadmill. In the first trial, they drank the **carbohydrate-only** formula. A week later, the same athletes did a similar trial but after drinking the **carbohydrate-protein** formula. Using the data in **Table 6**, test the following null hypothesis:

H_0: Mean distance is the same for the two drinks.

Table 6: Distances run (km) by six (6) athletes after two different drinks

Drink	Athlete 1	Athlete 2	Athlete 3	Athlete 4	Athlete 5	Athlete 6
Carb only	10.58	10.89	10.17	11.61	11.79	9.72
Carb + Protein	10.53	11.16	10.31	11.79	11.88	9.81

(15 minutes = 15 marks)

Question 12

A study is done looking at the effects of low and high fertiliser and manure on the yield of corn crops [7]. Five (5) replicate plots are planted, with all four (4) combinations of fertiliser and manure: see **Table 7**. A partially completed analysis of the study is below. State appropriate null hypotheses, complete the analysis in **Table 8** and draw conclusions about these hypotheses, and about the effects of fertiliser and manure on yield.

Table 7: Average yield of crop with different amounts of fertiliser and manure

	Low manure	**High manure**
Low fertiliser	12.3	14.9
High fertiliser	15.0	15.9

Table 8: Partially completed analysis of data

Source	**SS**	**df**	**MS**	**F**
A: Fertiliser	17.30	1		
B: Manure	15.84	1		
A×B	3.87	1		
Within	48.00	16		
Total	85.01	19		

(15 minutes = 15 marks)

FORMULAS and DATA SOURCES

Note – you may **NOT** need to use all of these.

1. $$\Pr(r) = \frac{n!}{r!(n-r)!} \times p^r (1-p)^{n-r}$$

2. $$\Pr(r) = \frac{e^{-\mu}\mu^r}{r!}$$

3. $$t = \frac{\overline{X}_1 - \overline{X}_2}{SE}$$

where

$$SE = \sqrt{\frac{s_c^2(n_1+n_2)}{n_1 \times n_2}}$$

$$s_c^2 = \frac{s_1^2(n_1-1)+s_2^2(n_2-1)}{(n_1+n_2-2)}$$

4. $$r = \frac{C_{xy}}{\sqrt{SS_x \times SS_y}}$$

where

$$C_{xy} = \sum XY - \frac{\sum X \sum Y}{n}$$

$$SS_x = \sum X^2 - \frac{\left(\sum X\right)^2}{n}$$

$$SS_y = \sum Y^2 - \frac{\left(\sum Y\right)^2}{n}$$

5. $$r_s = 1 - \frac{6\sum d^2}{(n^3-n)}$$

Data sources

1. https://onlinecourses.science.psu.edu/statprogram/node/158. Accessed: 28/03/18.
2. http://cba.ualr.edu/smartstat/topics/anova/example.pdfhttp://cba.ualr.edu/smartstat/topics/anova/example.pdf. Accessed: 28/03/18.
3. http://www.thepoultrysite.com/publications/1/egg-quality-handbook/5/internal-and-external-egg-quality/. Accessed: 27/03/18.
4. https://geographyfieldwork.com/SpearmansRank.htm. Accessed: 28/03/18.
5. https://www.shmoop.com/precalculus-statistics-probability/normal-distribution-examples.html. Accessed: 29/03/18.
6. https://statistics.laerd.com/stata-tutorials/paired-t-test-using-stata.php. Accessed: 29/03/18.
7. https://onlinecourses.science.psu.edu/stat500/node/216. Accessed: 29/03/18.

Any data with no source listed is from Keith McGuinness.